The Case for a Transportation/Highway Data Object Schema

- "*The dot on Line Problem* "-

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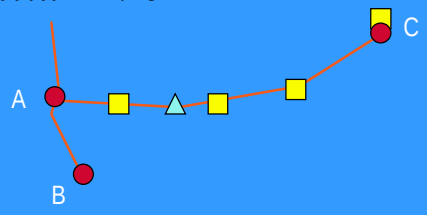
AASHTO GIS-T Symposium.
Arlington, VA April 9-11, 2001

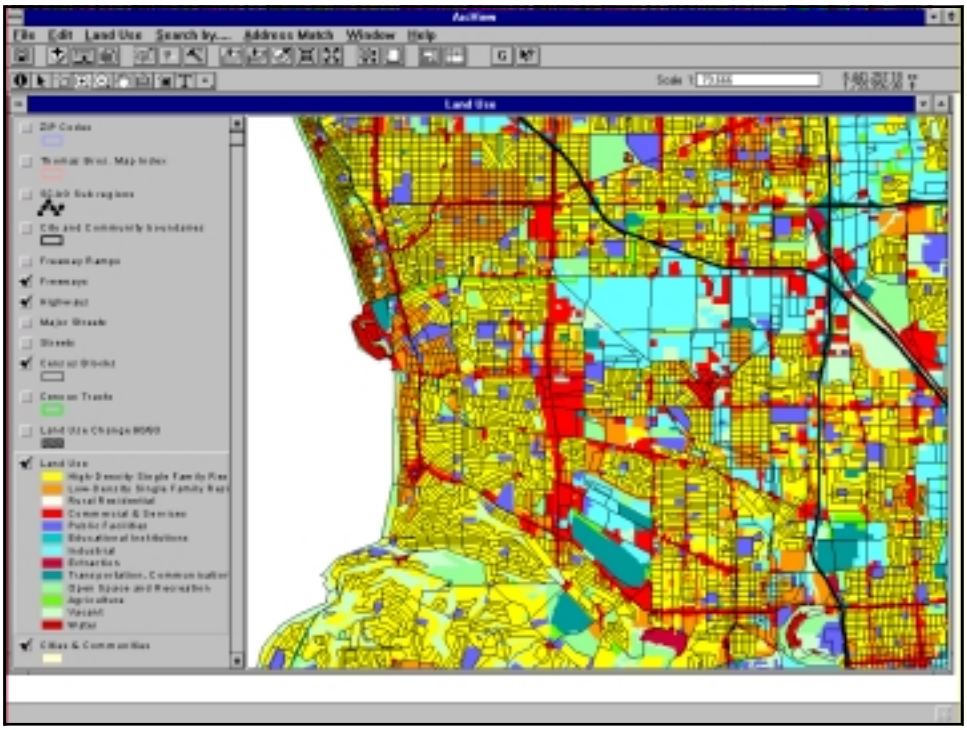
Overview

- History of transportation spatial activities
- What heard at conference
- Worry that we are on "*the right road*"
- Needs for a re-emphasis?
- Suggested a GIS-T practitioner's way forward?

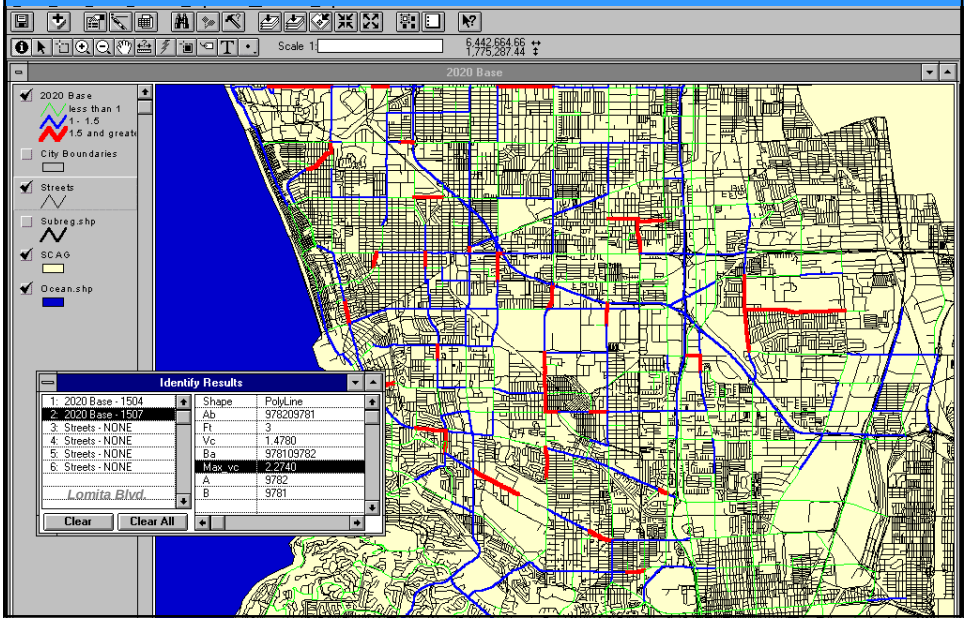
“An Old Game”

- Traversals
- ….Markers
- ……Highways
- ……..Trivia





Transportation Analysis



The Problem

- "The Dot on a line problem"
- GIS has always done "*polygon on polygon*" overlay
- We have never been able to do (practically)
  "*Point-on-Point overlay*"
  "*Network overlay*"

“Dot on line problem”

- We have not “solved this problem” until we have (reasonably) solved a pathway from “A to Z”
- Should DOT’s be investing in parts of the solution until they have?

What Has Happened in GIS-T?

- Data
- Numbering
- Models
- Technology

What we Know: Data

- The most expensive investment for an organization
- Created by many different organizations
- To solve many different problems
- Using many different methods and technologies

NSDI

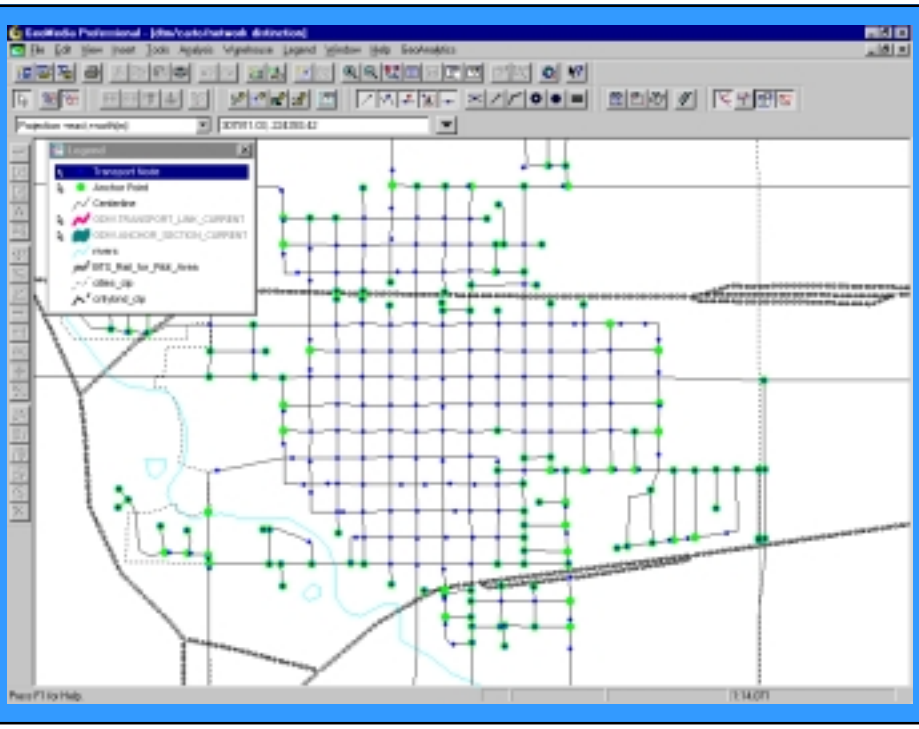
But . . .

- Data are hard to find
- Data are difficult to access
- Data are hard to integrate
- Data are not current
- Data are undocumented
- Data are incomplete

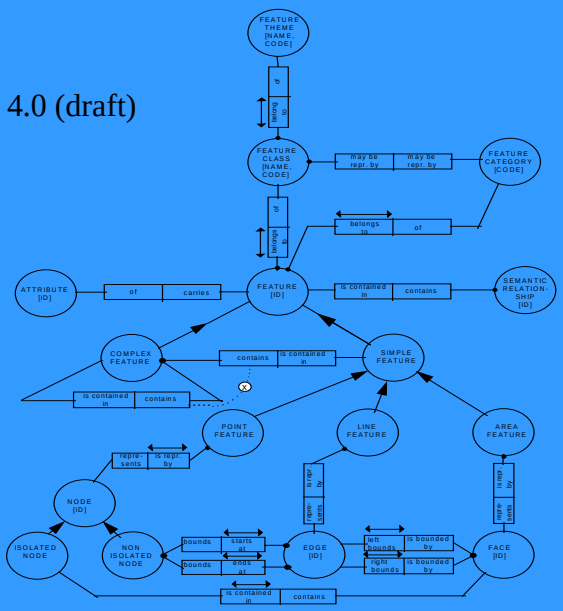
NSDI

What have We Done: Focus on Models

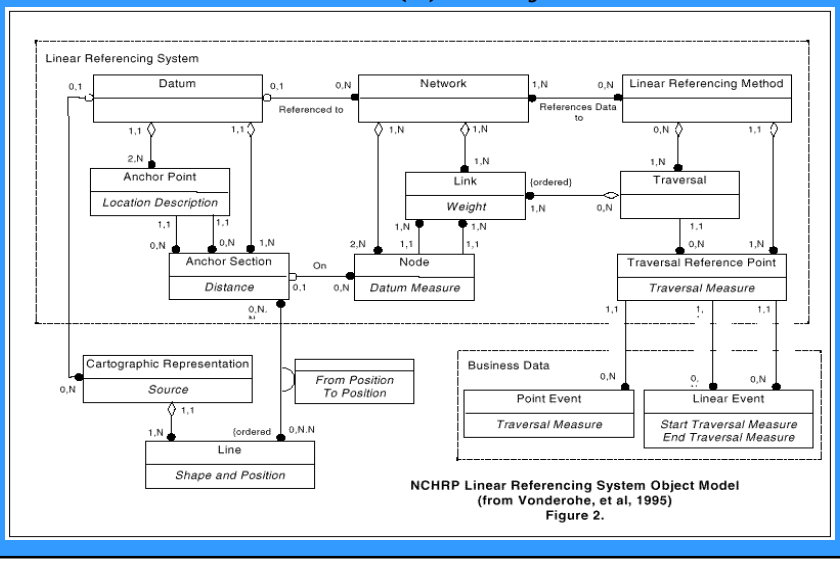
- TIGER
- FGDC
- NCHRP
- Dueker-Butler
- GDF 4.0 and XGDF
- ITS schema
- etc



GDF 4.0 (draft)

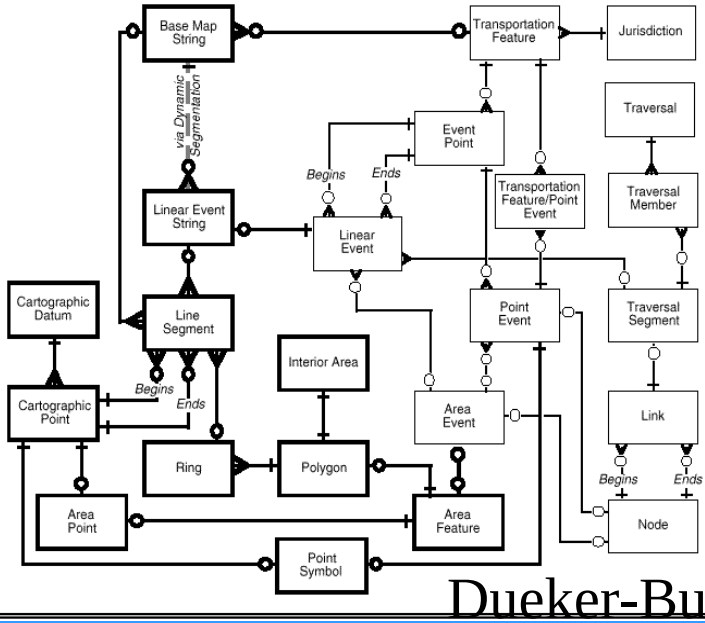


Linear Referencing Systems
NCHRP 20-27(2) - Object Model

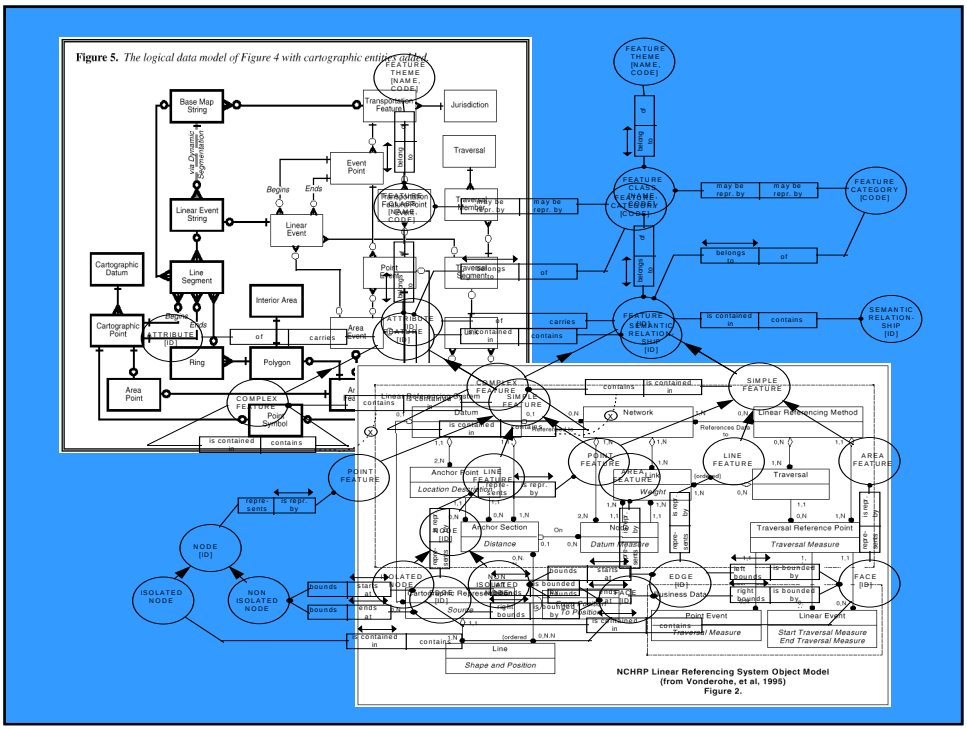


NCHRP Linear Referencing System Object Model (from Vonderohe, et al, 1995) Figure 2.

Figure 5. *The logical data model of Figure 4 with cartographic entities added.*



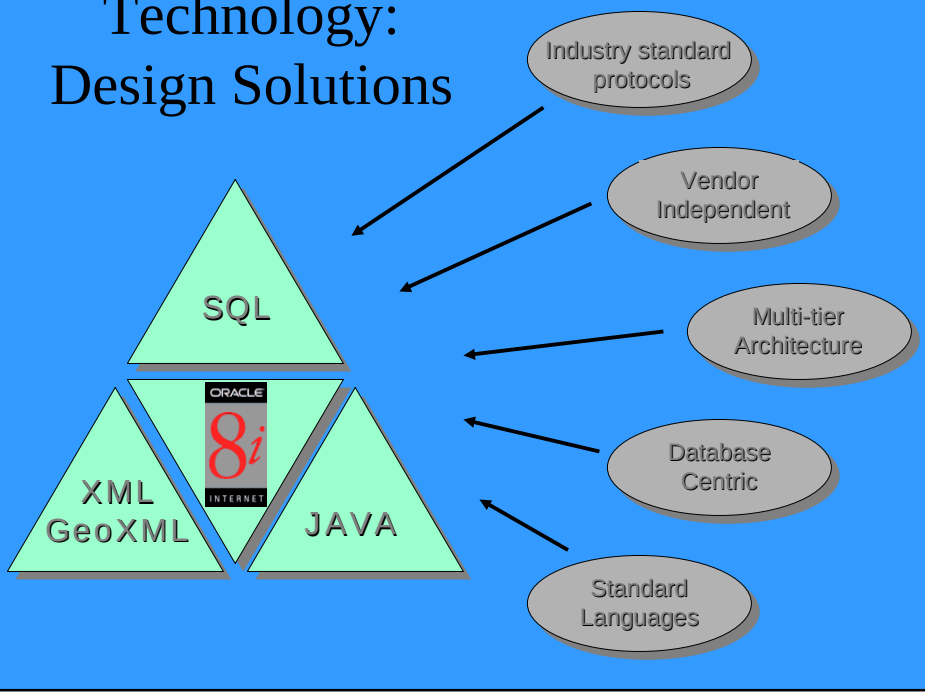
Dueker-Butler



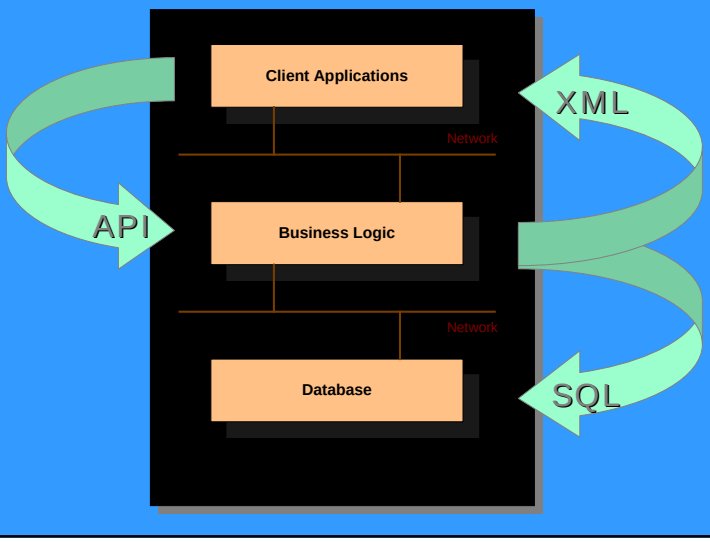
Key Issues in Road Data Models

- How do we '*chunk up*' the infrastructure?
- Does everyone need to use the same *chunks*? How are they identified?
- What is the least amount of work necessary to document the chunks?
- Who does this work?

Technology: Design Solutions

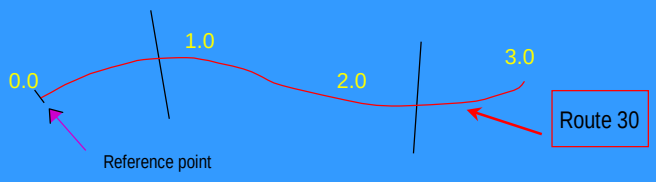


Technology: Conceptual Architecture



Technology – Software Dyn Seg:

Task / Step 3: Assign attributes along a route



Road attribute tables based on milepost measurement:

30. width

Fr	To	Val
0.0	0.5	20
0.5	1.9	25
1.9	2.0	20
2.0	3.0	22

30. condition

Fr	To	Val
0.0	0.2	A
0.2	0.7	B
0.7	0.8	A
0.8	1.7	C
1.7	2.5	B
2.5	3.0	A

30.class

Fr	To	Val
0.0	3.0	A

30.accident

Fr	To	Val
0.6	0.6	2

30.surface

Fr	To	Val
0.0	1.4	C1
1.4	1.7	A2
1.7	2.1	C2
2.1	3.0	A1

Fr = From

Technology : Software

- Software is being componentized and objectized
- Toolbox approach

!! *STEP BACK* !!

What do DOT's really need?

K.I.S.S.

What do DOT's Really Need?

- Simplicity
- Straightforwardness
- Lack of confusion
- Ideally solutions that help that from collection to storage

Highway Forms

- Highway designers taught to implement a variety of highway forms
- Highway Design Manual, CalTrans Design Manual
- These forms may have many variations, but common features
- Reflected in some of the existing models (UNETRANS, GDF)

HIGHWAY FEATURES AND NETWORKS

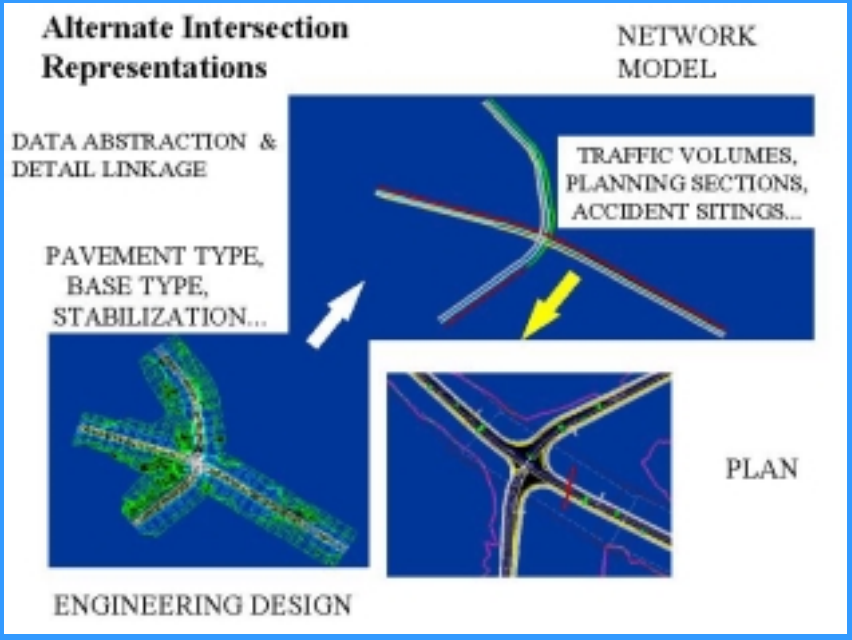
#	FEATURE	DESCRIPTION
1	**Travelway**	Portion of a roadway for the movement of vehicles, exclusive of shoulders ……..
2	**Divided Highway**	A highway with separated roadbeds for traffic in opposing directions …….
3	**Ramp**	A connecting roadway between a freeway or expressway and another highway, road, or hillside area ……
4	**Frontage**	A local street or road auxiliary to and located on the side of the arterial highway …….
5	**Tiered Roadways**	Roads not art grade, or with multiple levels, such as a dual carriageway bi-directional bridge ……
6	**One-way pairs)**	Divided highway on one direction …….
7	**Intersection**	The general area where two or more roadways join or cross
8	**Interchange**	A system for inter-connecting roadways in conjunction with one or more grade separations ……..
8	**Rotaries**	A traffic circle …….
9	**Cul-de-sacs**	A local street open at only one end only, with special provisions for turning around …….
10	**Dead-End street**	A local street open at only one end only, without special provisions for turning around …….

Transportation "Lego" TM

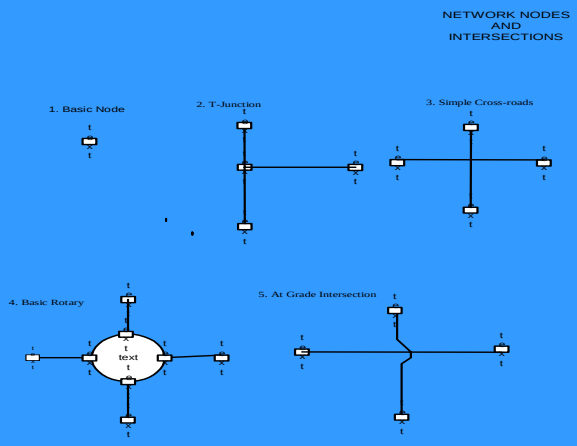
- Better described as a "Transportation Brio TM" as linear
- Modular, building blocks
- Interconnecting linear track pieces
- Set of logical data a management units
- Repeatable logic

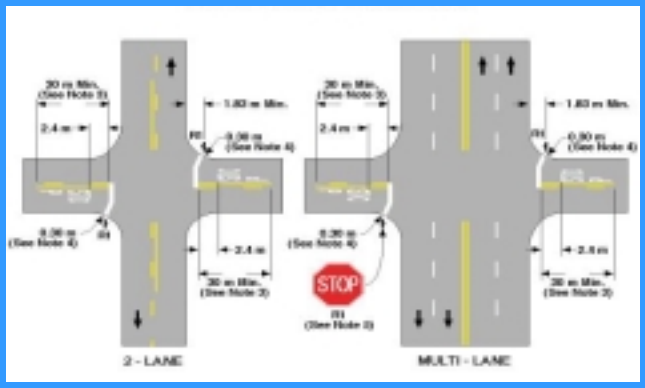
Pre-coded Transportation Network Objects

1. **Geometry:** I.e., I have width, height, scaqle characteristics, Draw at various scales, say 1:100,00 →.1:200
2. **Topology:** e.g., "Connect *cloverleaf* , Type 7.5, sub-type C, to a *dual lane highway*, Type 2.3, sub-type E
3. **Transportation Attribute:** Characteristics – lane width, type …. →80 Characteristics
4. **LRS trace:** through a cul-de-sac



Highway Type 7: Intersection





Transportation "Lego" TM:
Outline Form 1

1. Anchor Reference Points: bound
2. Control Section Form: similar
3. Local Linear Reference
4. Topology
5. Geometry

Transportation "Lego" TM:
Outline Form 2

6. Display Form
7. Linear Path Trace
8. Attribute Data
9. Universal Operators
10. Generalizability and Substitutability

Key Tasks: Transportation "Lego" ™

- *Creation:* How to partition the network
- *Maintenance:* How deal with geometric update
- *Use:* How to represent the Transportation Lego

Transportation "Lego" ™: Data Form Creation 1

1. Maintenance of Current Practices
2. Inventory of Current Parts
3. Basic Toolkit Selection
4. Toolkit Mapping
5. Creation of Classes of Anchor Reference Points

Transportation "Lego" TM:

Data Form Creation 2

6. Network Segmentation
7. Assignment of Geometries
8. Accuracy Measures
9. Automated Network Checking
10. Manual checks

Transportation "Lego" TM:

Maintenance 1

1. **Geometric Update:** Basic Update check: As new information is added, encoded checking
2. **Mapping Forms:** Add through defined templates
3. **Route calibration:**
    1. **As is**
    2. **Within transportation lego unit**
    3. **Route level update**

Transportation "Lego" ™:

Maintenance 2

- Topological Update
  - Connections maintained
  - Centerlines meet
- Attribute Update

Benefits of the Approach 1

1. LRS Facilitation
2. Recycle Logic
3. Standardization
4. Time stamping
5. Implementation support

Benefits of the Approach 2

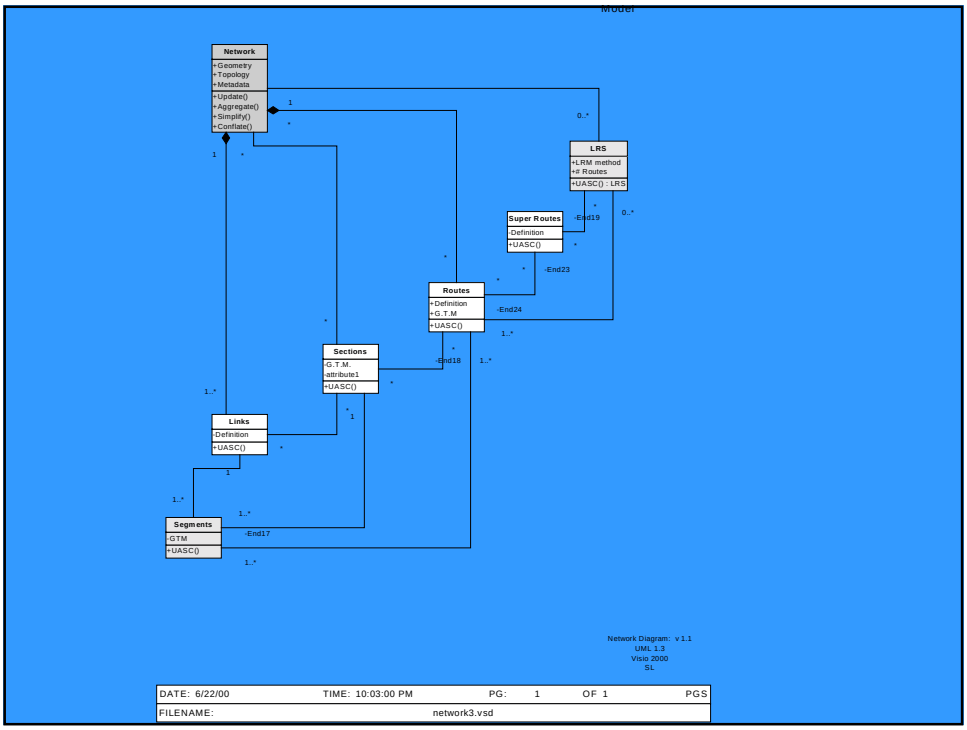
6. Interoperability
7. Reuse of data structures
8. Meta data
9. OO Methods
10. COTS Support

"*Middle Out*" Strategy

- Compromise between setting up and maintaining the spatial characteristics of networks
  - *Single-line* representations
  - *Complex Engineering-level* Detailed representations

Potential Weakness of the Approach

- Implementation cost
  - Institutional set-up
- Technical Issues
  - Conversion of existing networks
- COTS Support
  - Need vendor adoption
- Need for Further Field Testing
  - Pilots needed



Final Conclusions 1

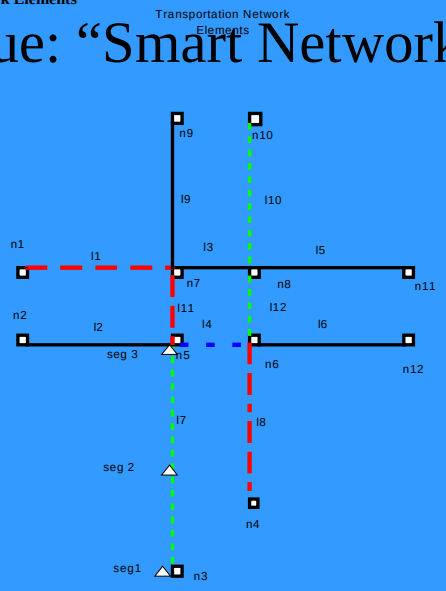
- More “data centric” approaches proposed
- A library of data management parts proposed
- Point, line, polygon …… AND transportation network parts

Final Conclusions 2

- Idea does go more “A to Z” (field capture to storage)
- Would best need national creation and support
- Toolbox approach for *both* **software** and **data**
- Completed in the in public interest

Figure 73 Transportation Network Elements

Deja Vue: "Smart Networks"



Transportation Linear Referencing Toolboxes: A Reflective Practitioner's Design Approach

Simon Lewis. MIT. Sept 2000